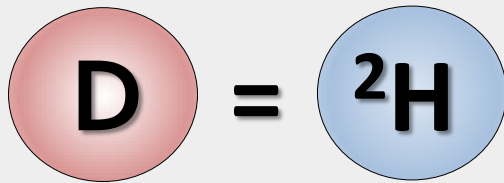# Deuterium content of natural water: an environmental risk factor for human disorders

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A. Chernopiatko

Budapest
4th International Congress on Deuterium Depletion
October 17- 18, 2019

Definitions

Isotopes are variants of a particular CHEMICAL ELEMENT with the same atomic number but with different atomic masses.

D = **^{2}H**

D = ^{2}H= Heavy Hydrogen=Deuterium

^{1}H   **Hydrogen**

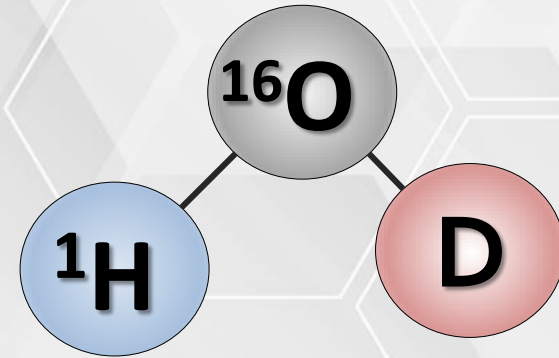^{16}O   **Oxygen 16**

^{17}O   **Heavy Oxygen 17**

^{18}O   **Heavy Oxygen 18**

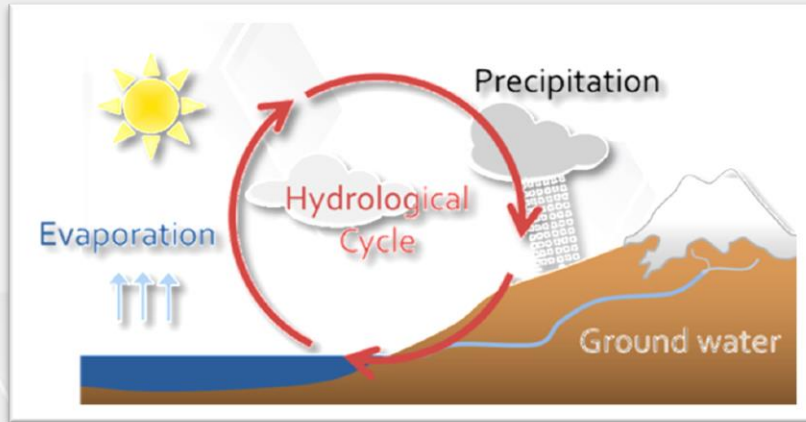**Isotopologues** are MOLECULES that differ only in their isotopic composition.

^{16}O

^{1}H   D

HOD = ^{1}HD^{16}O = ^{1}H^{2}H^{16}O = Semi-Heavy Water

Isotopologue	g/Kg WSMOW
^{1}H$_2$^{16}O	997,032536356
^{1}H$_2$^{18}O	2,227063738
^{1}H$_2$^{17}O	0,411509070
^{1}HD^{16}O	0,328000097
^{1}HD^{18}O	0,000728769
^{1}HD^{17}O	0,000134998
D$_2$^{16}O	0,000026900
D$_2$^{18}O	0,000000059
D$_2$^{17}O	0,000000011

Rothman et al., J. Quant. Spectrosc. Radiat. Transfer, 2003, 82, p.9

Definitions

- DDW - Deuterium-depleted water is water obtained by depleting deuterium-containing isotopologues from natural water.

- Low Deuterium Water is water with a lower concentration of deuterium than occurs naturally in certain area.

- "Light Water" is water with a higher concentration of the lightest stable isotopologue $^1H_2^{16}O$ than occurs naturally in certain area .

Both natural-hydrological processes and technological deuterium depletion lead to an increase isotopologue $^1H_2^{16}O$ and decrease HOD.

Deuterium generates a risk of depression

Chronic stress study

Exposure to rat

Restraint stress
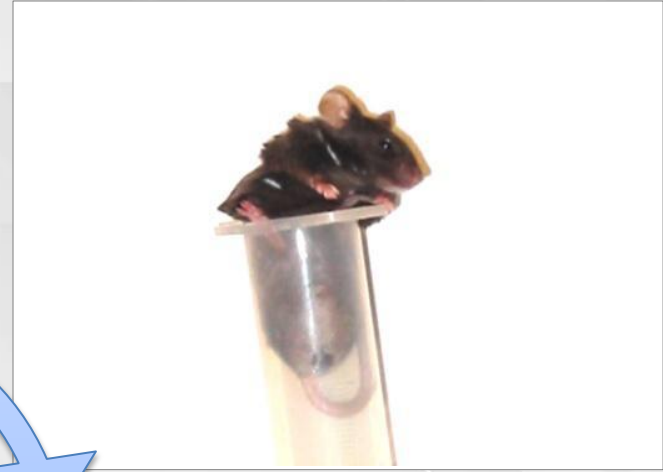
10 days

Resident-Intruder test «Social defeat»
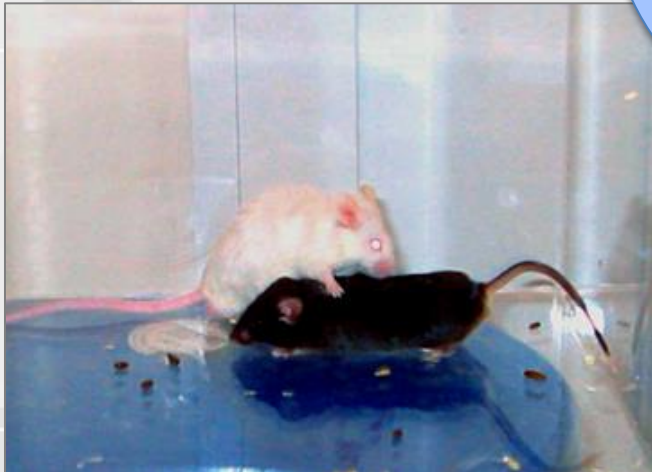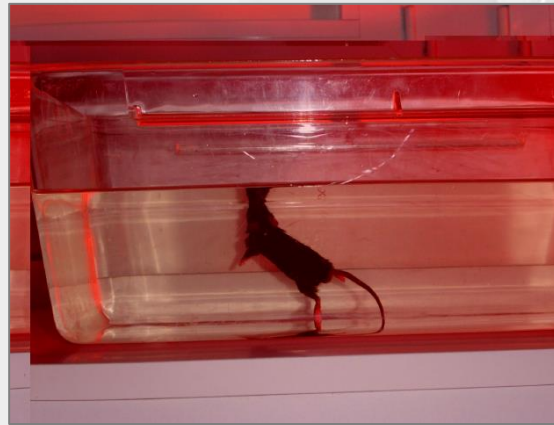
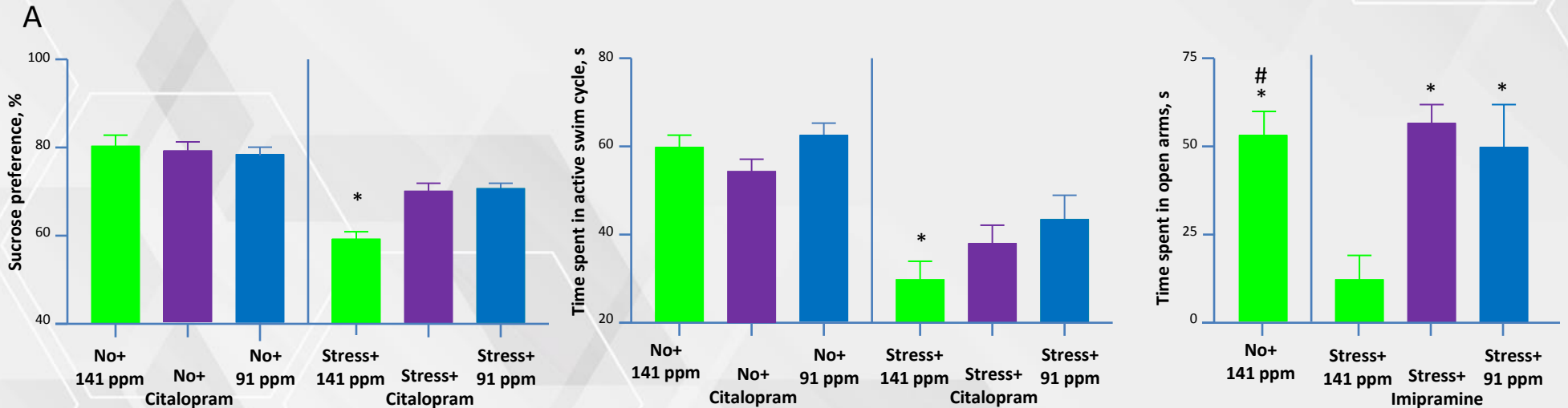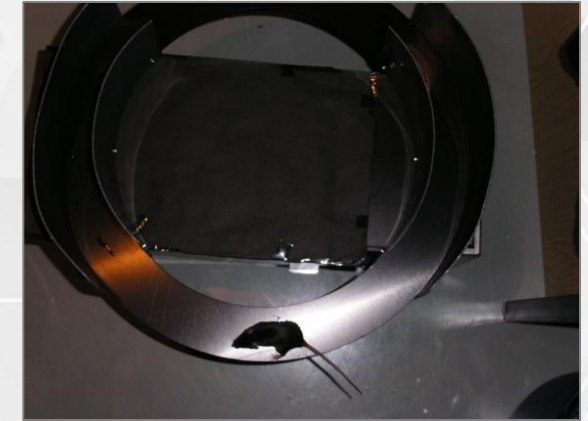**Tail Suspension**

Post-stress tests

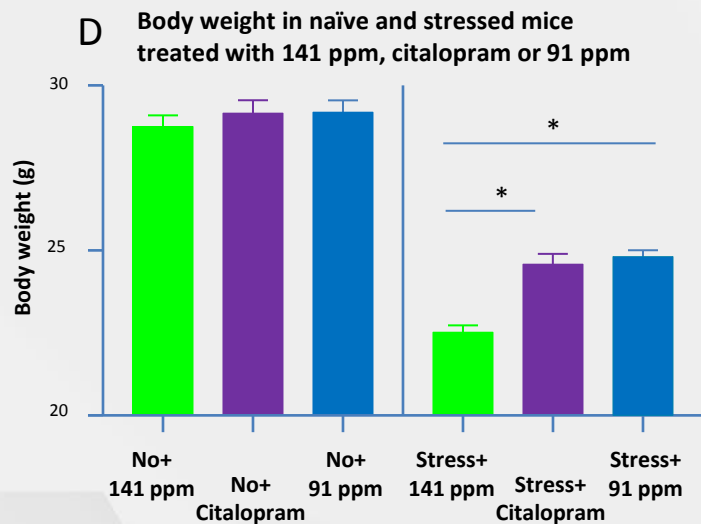## Sucrose preference test

Forced swim test «Behavioral despair»

O-maze test

A

Post-stress tests and EEG sleep study

Body weight, g
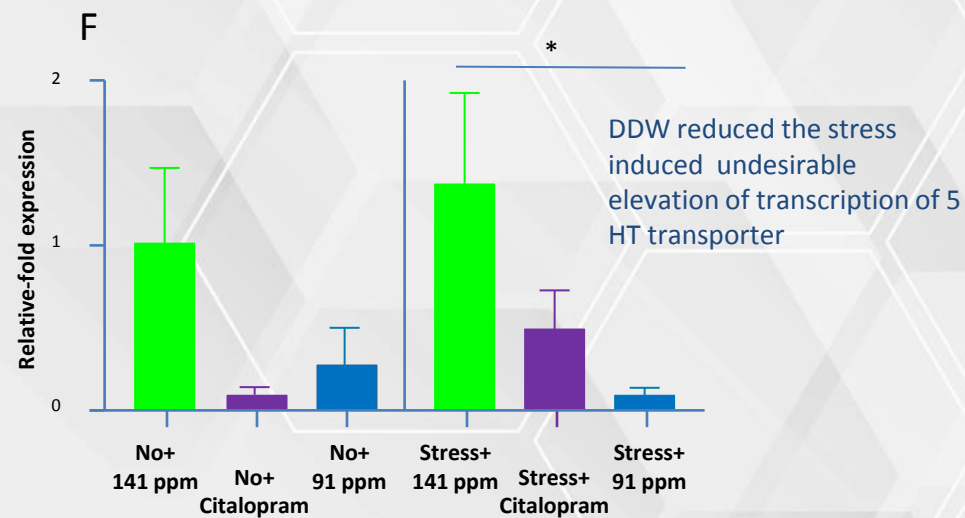
D

Body weight in naïve and stressed mice treated with 141 ppm, citalopram or 91 ppm

Coat state score, n

E

Coat score in naïve and stressed mice treated with 141 ppm, citalopram or 91 ppm
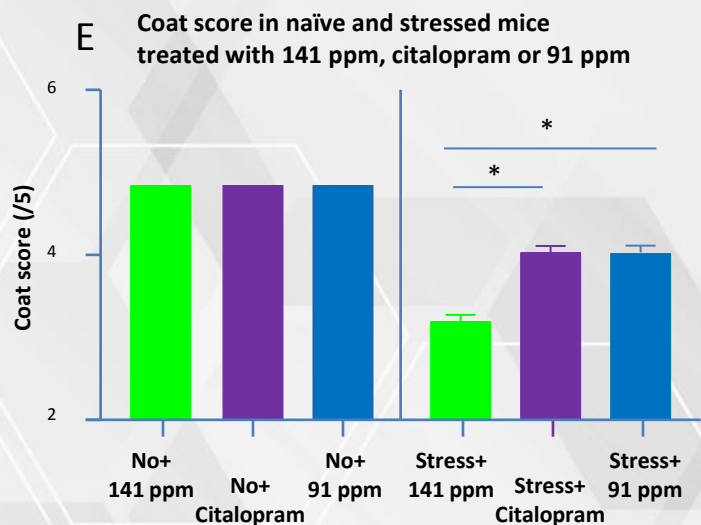
mRNA expression level of the 5-HT transporter (SERT)

F

DDW reduced the stress induced undesirable elevation of transcription of 5 HT transporter
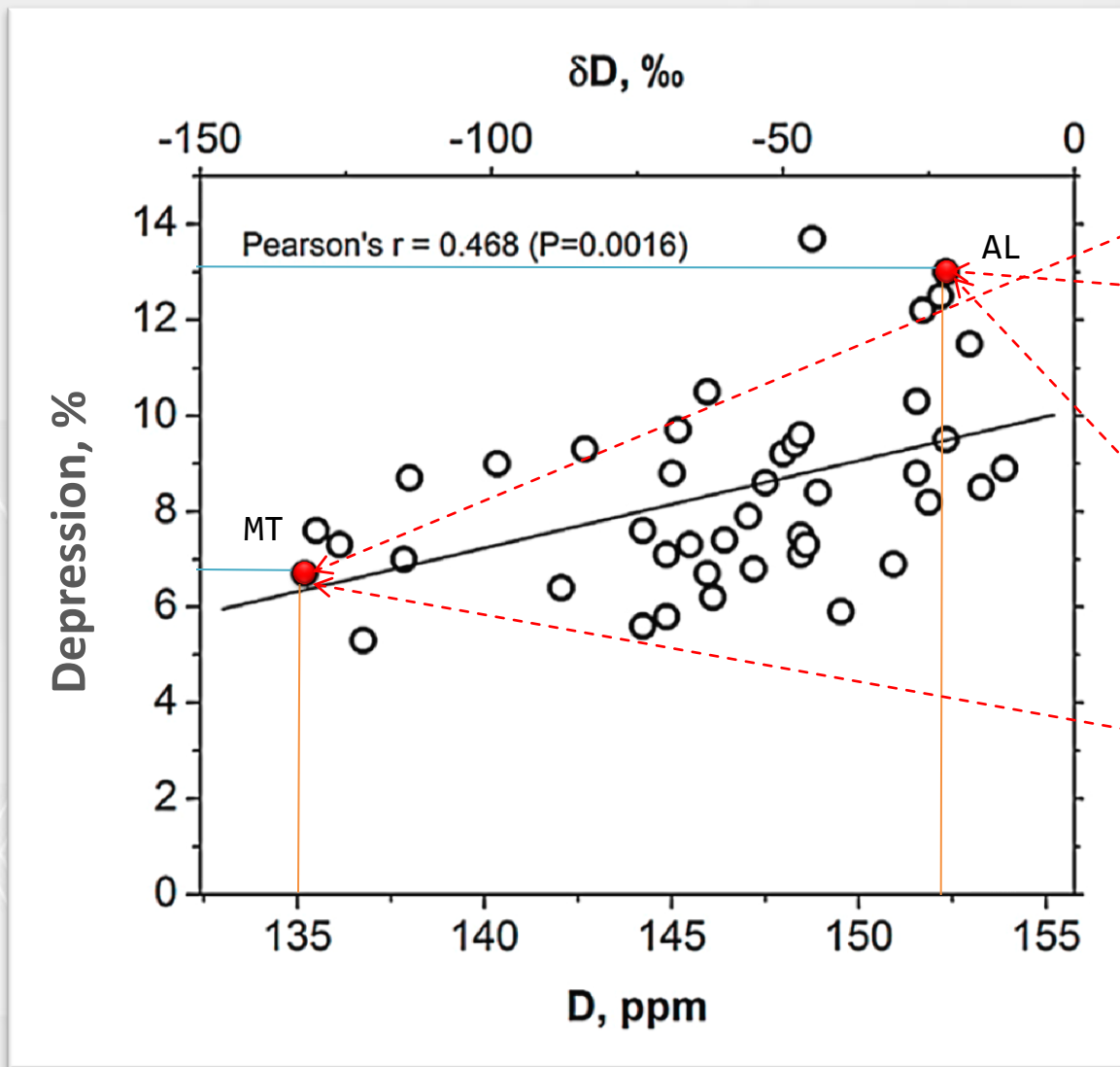
REM sleep
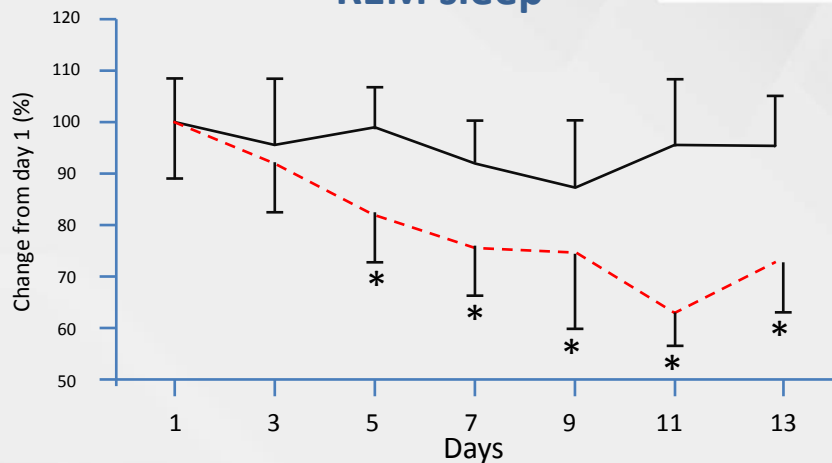
Correlation between reported rates of major depressive disorder in the US states and content of deuterium in tap water in the USA

Geographical distribution of average **deuterium content** in the tap water [National survey. Deuterium distribution in continental USA. Utah University]
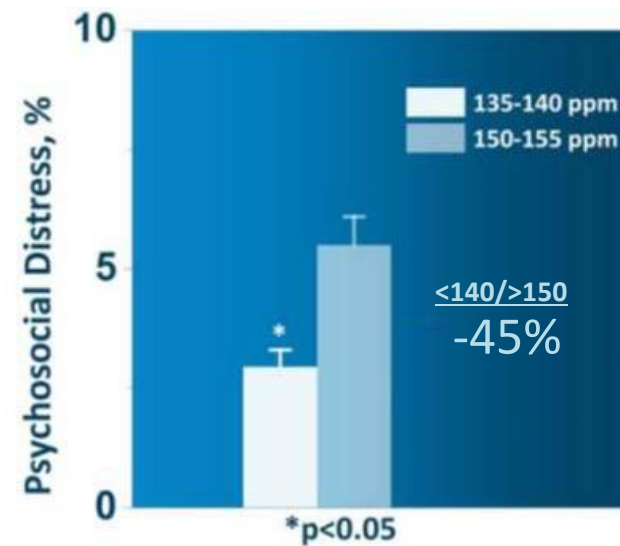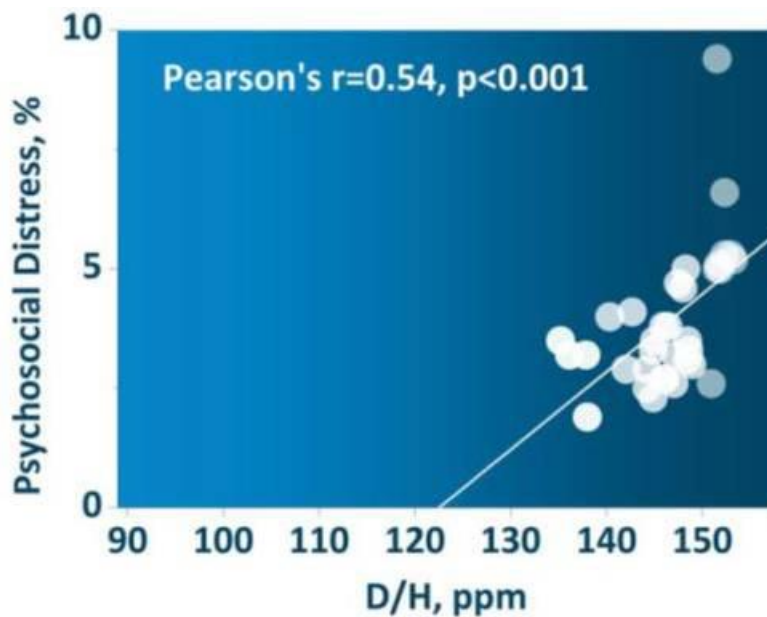
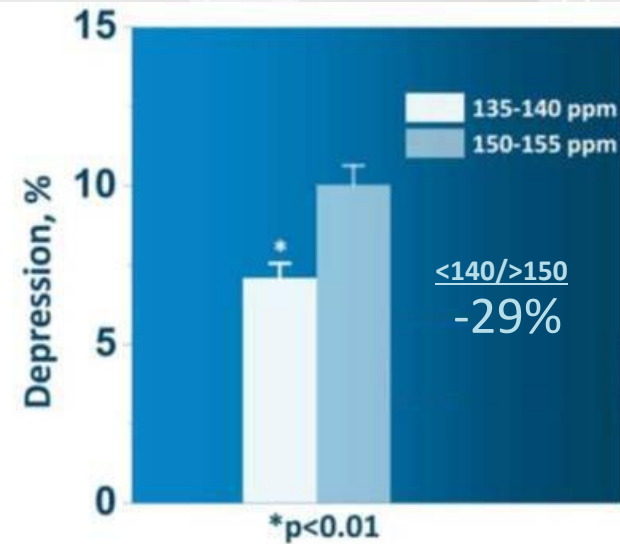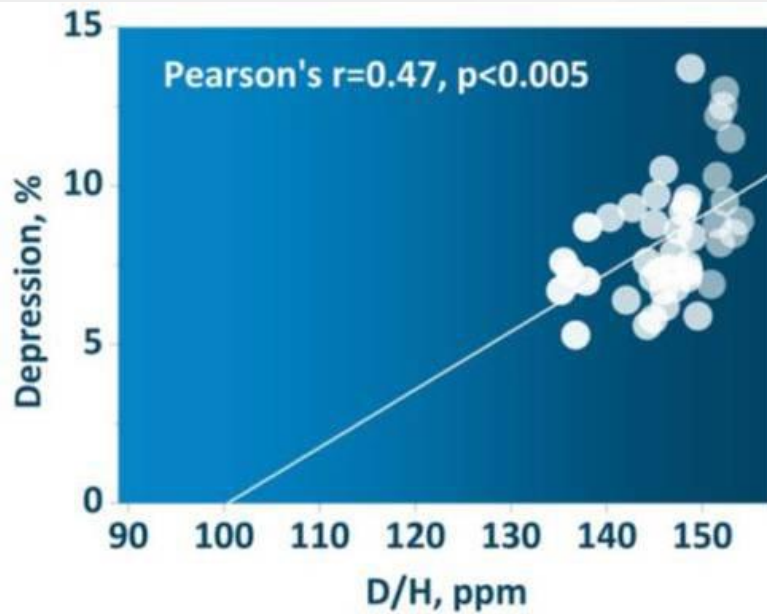The reported prevalence of individuals with **depression** in among adults aged ≥18 years in each US state [Centers for Disease Control and Prevention. Mental illness surveillance among adults in the USA).
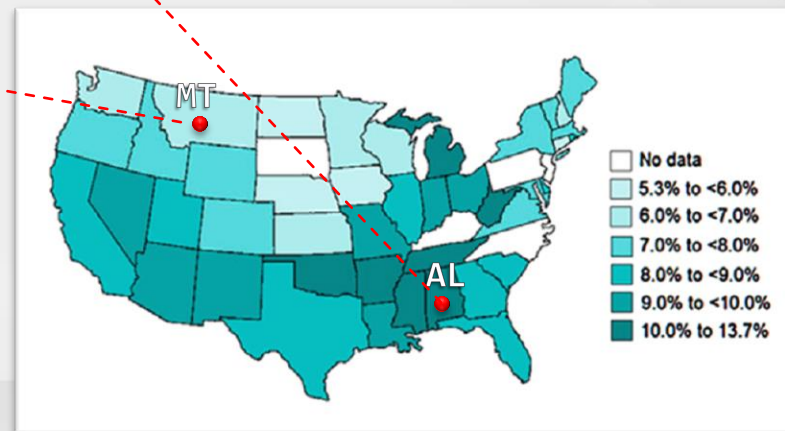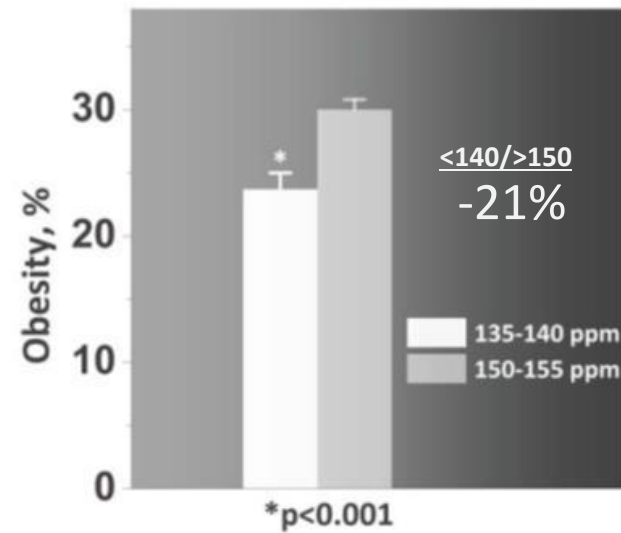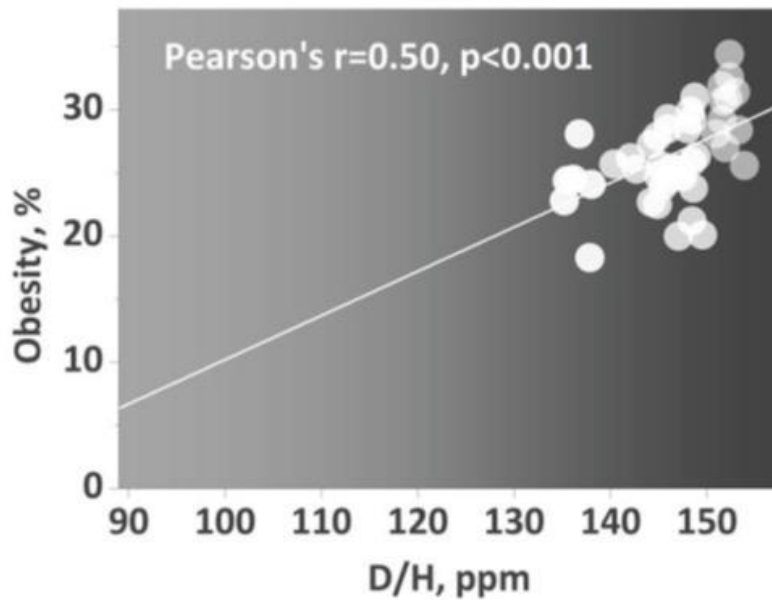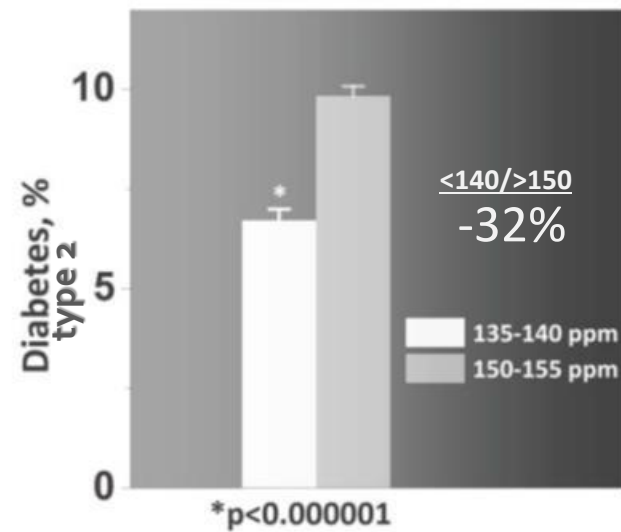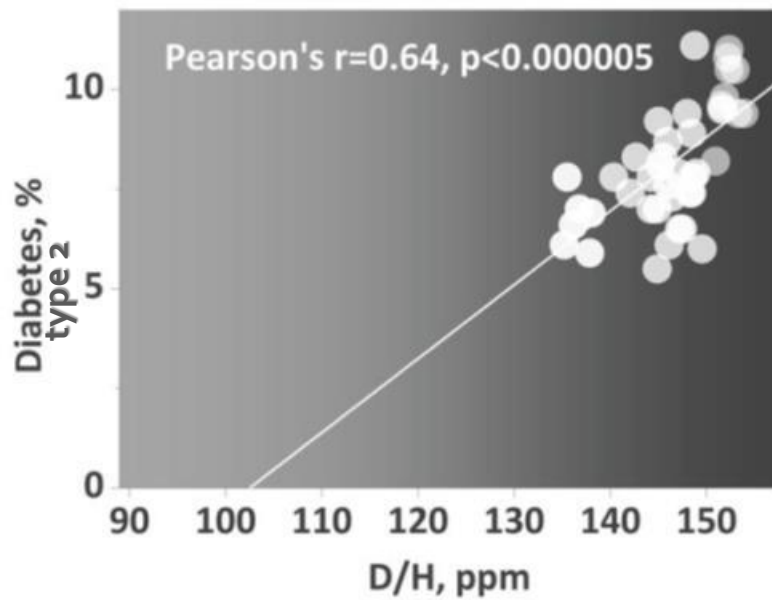
Mental disorders

Metabolic disorders

Cardiovascular disorders
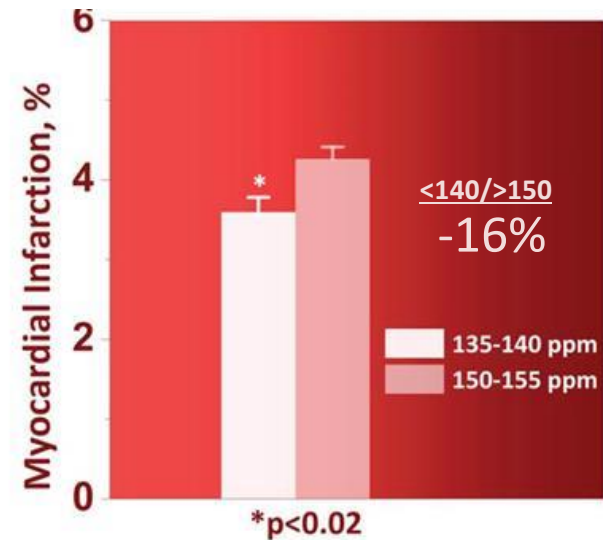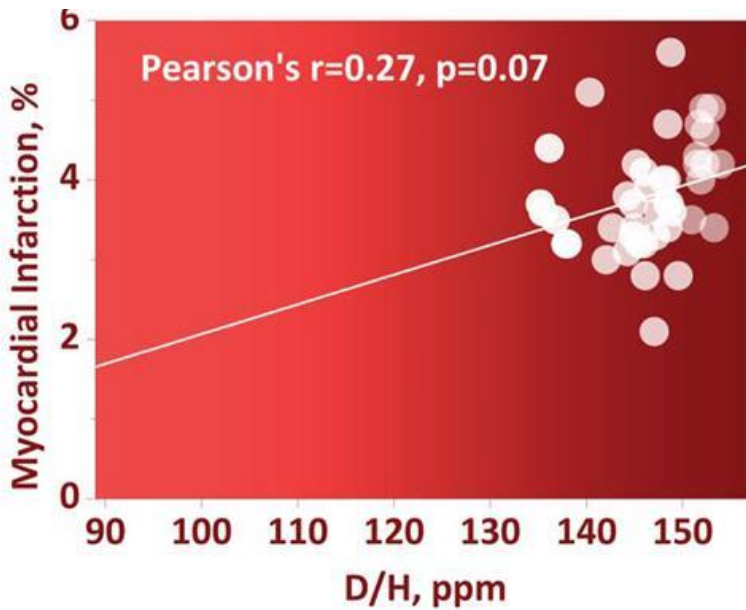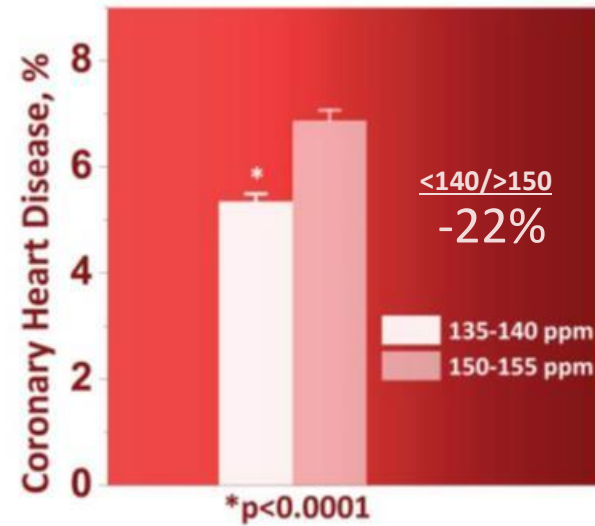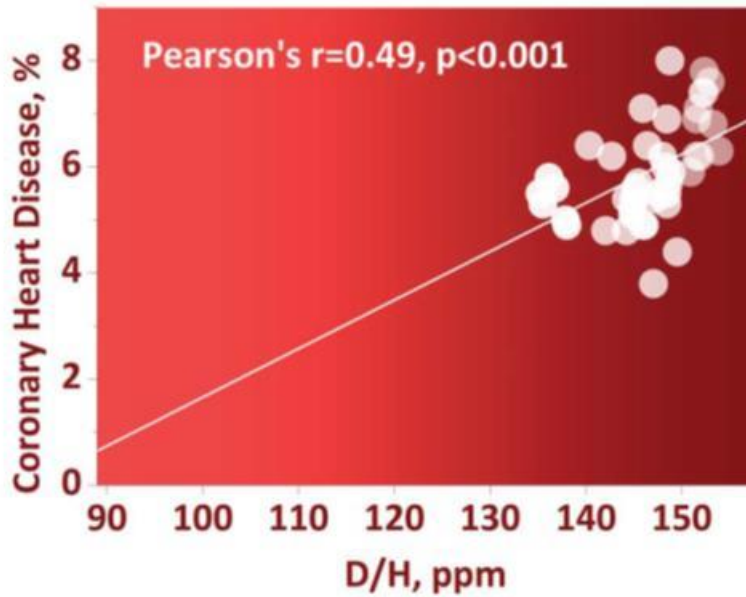
Cardiovascular disorders

Oral health

Among adults, age 65+
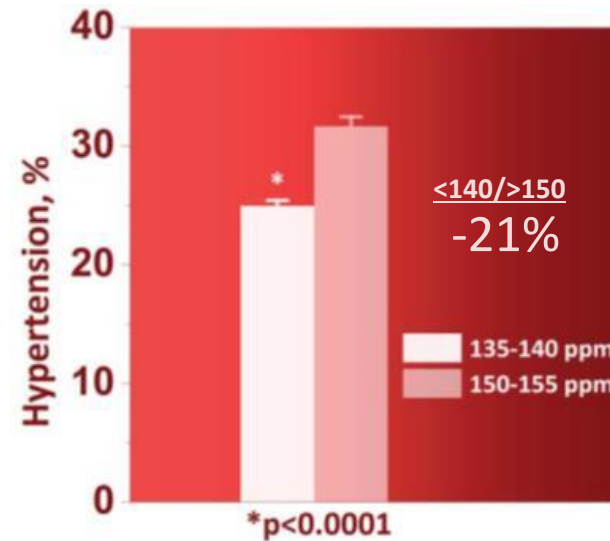
Oncology
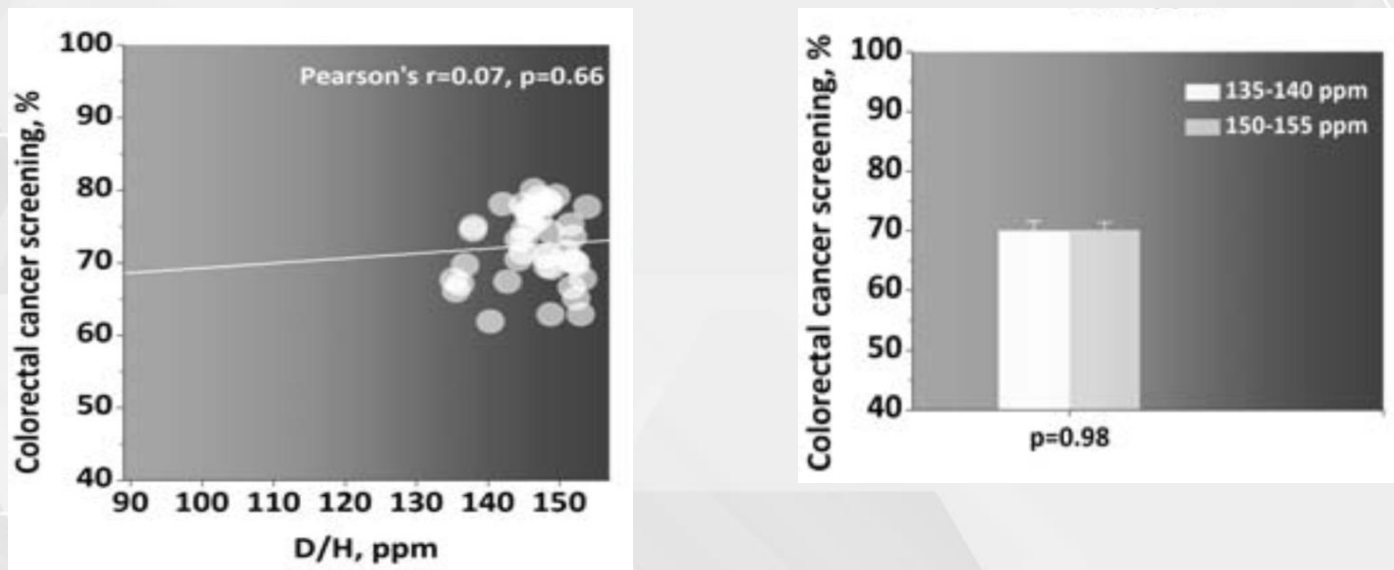
Summary

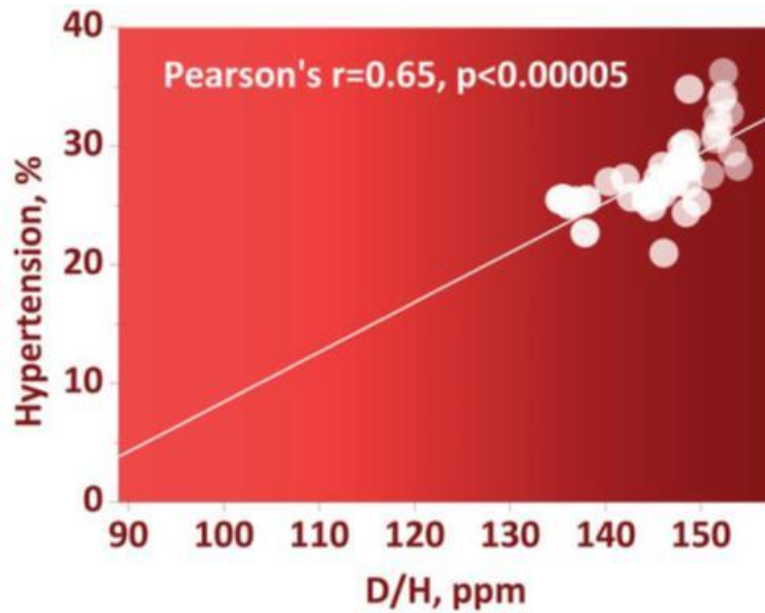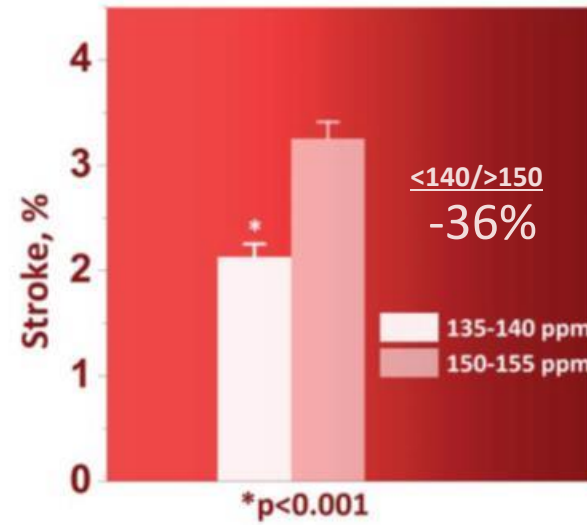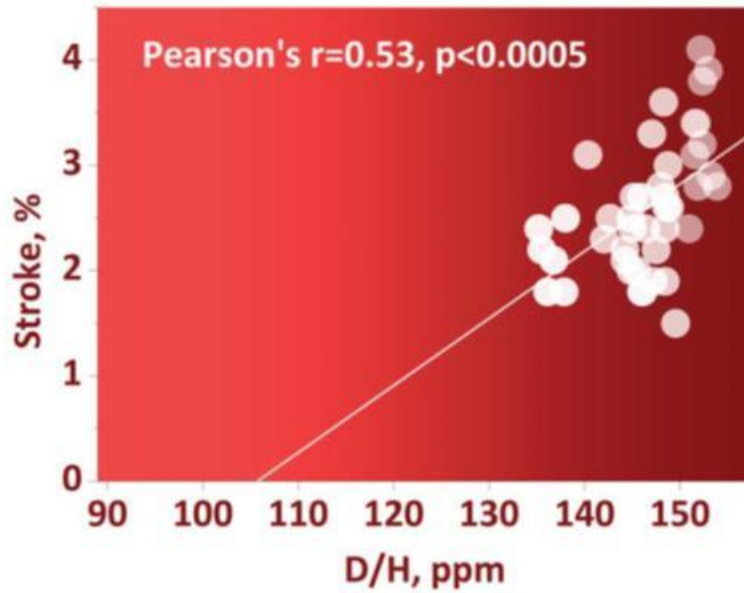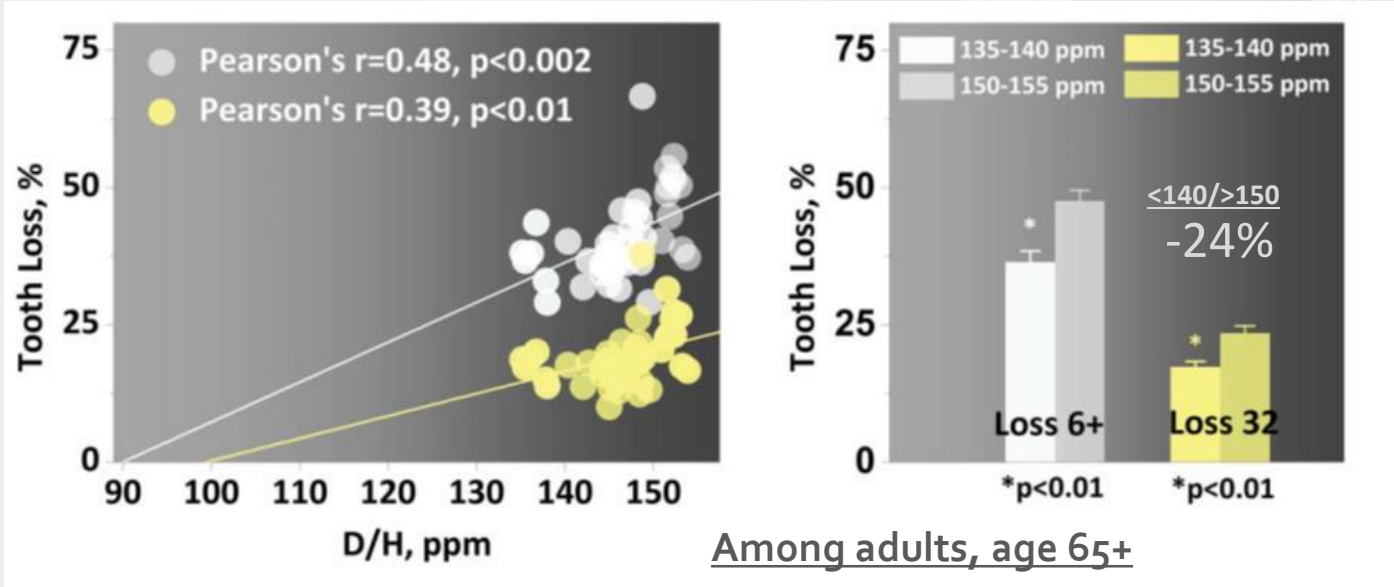| Disorders	Prevalence of disorders, < 140 ppm vs. >150 ppm					Correlation by states		
	Absolute <140 ppm	Absolute >150 ppm	Relative <140/>150	statistical significance p<	*	Pearson's coefficient	statistical significance p<	*
Psychosocial Distress	3.0%	5.5%	-45%	0.0005	*	0.54	0.001	*
Depression	7.1%	10.0%	-29%	0.01	*	0.47	0.005	*
Diabetes type 2	6.7%	9.8%	-32%	0.000001	*	0.64	0.000005	*
Obesity	23.7%	30.0%	-21%	0.001	*	0.50	0.001	*
Hypertension	25.0%	31.7%	-21%	0.0001	*	0.65	0.00005	*
Coronary Heart Disease	5.4%	6.9%	-22%	0.0001	*	0.49	0.001	*
Stroke	2.1%	3.3%	-36%	0.001	*	0.43	0.005	*
Myocardial Infarction	3.6%	4.3%	-16%	0.02	*	0.27	0.07	
Loss of 6 or more teeth	36.4%	47.6%	-24%	0.01	*	0.48	0.002	*

Replacement of plain water with deuterium depleted water may significantly reduce the risk of disorders

That's one small step in deuterium depletion, one giant leap for mankind's health.

СЕЛЬСКОЕ ХОЗЯЙСТВО СИБИРИ

Охрана природы—наше общее дело!

7

1961

ОМСК

Thank you!

lightwater.com

Supplemental material

Principles of Stable Isotope Geochemistry
2nd Edition
Zachary Sharp

Table 2.1. *Common Mistakes in Terminology and Phraseology*

Mistake	Recommended Expressions	Explanation
referring to the symbol δ as 'del'	Since the time of the early Greeks, the name of this symbol has been and remains **delta**.	The word *del* describes either of two things in mathematics and science: an operator (∇) or the partial derivative (∂)
$\delta^{13}C$ composition	$\delta^{13}C$ value; carbon isotope composition	$\delta^{13}C$ values are numbers and a *composition of numbers* has no meaning.
Isotopically depleted water	^{18}O (or D) depleted water	A given sample of water is neither depleted nor enriched in isotopes.
Stable water isotopes have been widely used as tracers. . .	Stable O and H isotope ratios in water have been used. . .	Only elements have isotopes. It is the H and O that has the isotopes, not H_2O.
heavy (light) $\delta^{18}O$ values	high (low) $\delta^{18}O$ values	As numbers, δ-values can be high or low, positive or negative, but not heavy or light.
Isotopically negative	relatively low δ values	Isotopic ratios are not negative or positive; they are lower or higher than those of the standards.
depleted $\delta^{13}C$ value	low $\delta^{13}C$ value (relative to another)	$\delta^{13}C$ values are numbers and, as such, they cannot be depleted or enriched.
enriched (depleted) carbonates.	isotopically heavy (light) carbonates	The words *enrich* and *deplete* are overused and much abused. These words should be reserved for describing a **process** that changes the content of the heavy isotope of the element in some substance.
enriched (depleted) compositions	(relatively) ^{18}O-rich or ^{13}C-poor carbonates	
depleted carbon reservoir	reservoir of (isotopically) light carbon	
oxygen isotopes **in** chert; inferred from carbon isotopes; isotopes of soil water	oxygen isotope **ratio (composition) of** chert; inferred from carbon isotope **measurements**; isotopic composition of soil water	Such written mistakes are a carryover from loose oral communication.